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TEACHING OF CHEMISTRY AND PHYSICS IN THE UNITED STATES.*

II.

In normal schools, the time which can be assigned to work in chemistry and physics is necessarily limited; it becomes then all-important that it should be of the right sort. As Professor Clarke points out, it is not the purpose of such schools to train specialists in any one department of learning, neither should they attempt to give a broad general education. The sole function of a normal school is to fit students for the profession of teaching.

The Bureau of Education has taken pains to enquire how far the scientific work in normal schools has complied with the plan which was originally formed to preserve them within their original functions.

On this point the report states that :

"An examination of the evidence presented in this report will show a great diversity among the various normal schools with respect to chemistry and physics. By far the larger number of them treat these sciences exactly as they are treated in secondary institutions and the smaller colleges; that is, they teach the elements of both subjects, partly by text books and partly by lectures; a few experiments are exhibited, and laboratory work on the part of the students is entirely ignored. In other words, the practice of these schools with reference to the sciences does not accord with the theory upon which they were originally founded."

A small number of normal schools, however,

"Adopt a more rational policy. Recognizing the fact that their students may be called upon to teach chemistry and physics, they endeavor to train them intelligently in methods of instruction."

Respecting instruction in chemistry and physics in universities, colleges and schools of science, much interesting matter is presented, giving in detail the actual work done in these branches of science at the most important institutions of this character.

The general conclusion drawn by Professor Clarke on the character of scientific instruction in universities and colleges is not favorable to such establishments. He says:

"Many high schools are actually doing more and better work with these sciences than is done in a very considerable number of colleges bearing good reputations."

The low standard of scientific work in universities and colleges is attributed by the report to persistent use "of the old-fashioned plan of a fix curriculum."

"Clearly these colleges could, if they would, build upon the work of the preparatory schools as a foundation, and, with no more cost of time, carry their pupils much further than they do now. The present subordinate position of scientific studies is undoubtedly due to the continuation in so many localities of the old-fashioned plan of a fixed curriculum. Given a college in which the latter still holds its own and in which the classics and mathematics have been for many years the dominant subjects of study, and we have an institution wherein but little time can be given to any one of the sciences. One term, from a third to half an academic year in length, is all that is usually allowed to chemistry. This is absurdly inadequate as one term in Latin or one term in mathematics, with no previous preparation, would be. By this system the sciences are not only underrated, but smattering is directly encouraged. The student trained in it can have no definite idea of scientific methods, scientific reasoning, or the scientific spirit. Even the professor in charge of the sciences may be himself a smatterer, teaching several branches without ever having received a systematic training in any one of them. Such teachers, who keep ahead of their classes by only a few lessons, are unfortunately very common, and with them the modern laboratory methods are simply impossible."

Professor Clarke may be correct in these general conclusions, but it is agreeable to refer to the many honorable exceptions, colleges where scientific instruction is offered on the most liberal and enlightened basis.

It would be difficult to take exception to the courses of study in Chemistry and Physics at Columbia College, New York City, where the collection of physical apparatus is the finest in the country, and three laboratories provided for the use of students.

The instruction in Physics and Chemistry at the school of mines of this college is thus described in the report:—

Physics.—Professor, O. N. Rood; mechanics is taught by Professor William G. Peck. The first year students, in the first term, take up the subject of heat, including the steam engine, and acoustics. In the second term they study optics, electricity and magnetism. The courses are illustrated by experiments and problems and are pre-

* Circulars of Information of the Bureau of Education No. 6. 1881.
A report on the teaching of Chemistry and Physics in the United States, by Frank Wigglesworth Clarke, S. B., Professor of Chemistry and Physics in the University of Cincinnati. Washington, 1881.

scribed for all students. To the third year class, lectures are delivered upon electro-statics, the mechanical theory of heat, mathematical optics, and the undulatory theory of light. Some of the lectures are accompanied by experimental demonstrations. This course is required of all students except those in chemistry, with whom it is optional.

Mechanics is taught in the third year to the students in mining engineering, civil engineering, and metallurgy. The mechanics of solids is studied in the first term and the mechanics of fluids in the second.

No physical laboratory work is mentioned in the handbook of information.

Chemistry.—Professor, C. F. Chandler; instructors, Elwyn Waller, Pierre De Peyster Ricketts, Alexis A. Julien, James S. C. Wells, Henry C. Bowen, Francis N, Holbrook, and Louis H. Laudy. General inorganic chemistry, stoichiometry, qualitative analysis, quantitative analysis, and blowpiping are required studies in all the courses. Assaying is taught to students in mining, metallurgy, and chemistry. In the geological and chemical courses, organic chemistry is studied. The chemical students have also a large amount of work in applied chemistry. Quantitative blowpipe analysis is an optional study in all of the courses.

In general chemistry the first year students attend three exercises a week throughout the year. This course is preliminary to practical instruction in the laboratory. The students are drilled upon the lectures, with free use of the best text books, and take notes which must be submitted to the professor. At the end of the year there is a rigid examination. The second class also attend three times a week during the year, and receive instruction in theoretical chemistry adapted to the needs of special scientific students.

For analytical chemistry there are three laboratories, one for qualitative analysis, one for quantitative analysis, and a third for assaying. Each of these is thoroughly equipped and is in the special charge of an instructor with an assistant. Every student is provided with a convenient table containing drawers and cupboards, and is supplied with a complete outfit of apparatus and reagents. The laboratories are open daily, except Saturdays, Sundays, holidays, and vacations, from 10 A. M. to 4 P. M.

During the second year, qualitative analysis is taught by lectures, blackboard exercises, and constant laboratory practice. The spectroscope is freely used. When the student shows, by written and experimental examination, that he is sufficiently familiar with qualitative work, he is allowed to enter the quantitative laboratory. In the third and fourth years, quantitative analysis is taught, the laboratory exercises being accompanied still by lectures and blackboard work. The laboratory course is graded after the usual manner, the student beginning with comparatively simple substances of known composition and passing on by degrees to the analysis of more complex bodies, such as coals, pig iron, various ores, slags, mattes, and so on. Both volumetric and gravimetric methods are employed. In the fourth year the student is admitted to the assay laboratory, where he is furnished with a suitable table and a set of assaying apparatus. Here he has access to crucible and muffle furnaces and to volumetric apparatus for the assay of alloys of gold and silver. The general principles and special methods of assaying are described in the lecture-room, and at the same time the ores of the various metals and their appropriate fluxes are exhibited and described. The student is then supplied with different ores and is required to assay each ore in duplicate under the supervision of the instructor.

Stoichiometry is taught, by lectures and blackboard exercises, as a part of the course in general chemistry, through the first and second years; and its practical applications are developed in lectures upon quantitative analysis and assaying.

In applied chemistry, the instruction extends through the third and fourth years and consists of lectures illustrated by experiments, diagrams, and specimens. The cabinet of industrial chemistry is very large and complete, containing several thousand specimens and materials and products.

It will be noticed that the course of study at this college is thorough, practical and technical, "the design being to train analysts and technologists." Professor Chandler has brought to bear in this work the full weight of his well-known administrative abilities, and the School of Mines of the City of New York may well be taken as a model for all future establishments of the same class on this continent.

A perusal of this report will make the fact evident, that in this country ample facilities exist for the most thorough instruction in both Physics and Chemistry, and the record shows that since the year 1865 the course of instruction in these departments of science has been one of continuous progress.

Of Columbia College, New York, we have spoken, but it might appear that we made an invidious selection if we did not refer to other prominent centres of physical and chemical research. Among many of such we may name the Massachusetts Institute of Technology; the Stevens Institute, Hoboken; the Universities of Pennsylvania, Virginia and Cincinnati; Yale, Harvard and the Johns Hopkins University. To-day the higher chemistry can be studied in a score of places where twenty years ago no adequate facilities were offered, and the modern physics, with its mathematical methods and its laboratories, is rapidly coming into vogue.

One other feature of the new movement remains to be mentioned, namely, the spread of scientific teaching downward into the secondary schools. These, too, are organizing laboratories, teaching young scholars to see and experiment for themselves, preparing the way for higher work, and rendering the latter more easily possible. The "summer schools" of chemistry at Harvard and elsewhere, the Woman's

Laboratory at the Massachusetts Institute of Technology, and such-like enterprises are doing much in this direction. To-day Chemistry and Physics are taught in nearly all the academies and high schools of the land; so that the larger colleges, whenever they see fit, may easily require from the candidate for admission a wider knowledge of these sciences than they themselves taught a dozen years ago. When and in what manner the present scientific movement shall culminate, no one can say; but the fact of growth is evident everywhere. This report is an attempt to catch the present aspect of affairs and fix it in a permanent record.

ON THE SOURCES OF ENERGY IN NATURE AVAILABLE TO MAN FOR THE PRODUCTION OF MECHANICAL EFFECT.*

By Sir William Thomson, F. R. S.

During the fifty years' life of the British Association, the advancement of Science for which it has lived and worked so well has not been more marked in any department than in one which belongs very decidedly to the Mathematical and Physical Section—the science of Energy. The very name energy, though first used in its present sense by Dr. Thomas Young about the beginning of this century, has only come into use practically after the doctrine which defines it had, during the first half of the British Association's life, been raised from a mere formula of mathematical dynamics to the position it now holds of a principle pervading all nature and guiding the investigator in every field of science.

A little article communicated to the Royal Society of Edinburgh a short time before the commencement of the epoch of energy under the title "On the Sources Available to Man for the Production of Mechanical Effect,"† contained the following:

"Men can obtain mechanical effect for their own purposes by working mechanically themselves, and directing other animals to work for them, or by using natural heat, the gravitation of descending solid masses, the natural motions of water and air, and the heat, or galvanic currents, or other mechanical effects produced by chemical combination, but in no other way at present known. Hence the stores from which mechanical effect may be drawn by man belong to one or other of the following classes:

"I. The food of animals.

"II. Natural heat.

"III. Solid matter found in elevated positions.

"IV. The natural motions of water and air.

"V. Natural combustibles (as wood, coal, coal-gas, oils, marsh-gas, diamond, native sulphur, native metals, metoric iron.)

"VI. Artificial combustibles (as smelted or electrically-deposited metals, hydrogen, phosphorus).

"In the present communication, known facts in natural history and physical science, with reference to the sources from which these stores have derived their mechanical energies, are adduced to establish the following general conclusions:

"1. *Heat radiated from the sun* (sunlight being included in this term) *is the principal source of mechanical effect available to man.*‡ From it is derived the whole mechanical effect obtained by means of animals working, water-wheels worked by rivers, steam-engines, galvanic engines, wind-mills, and the sails of ships.

"2. The motions of the earth, moon, and sun, and their mutual attractions, constitute an important source of available mechanical effect. From them all, but chiefly no doubt from the earth's motion of rotation, is derived the mechanical effect of water-wheels driven by the tides.

"3. The other known sources of mechanical effect available to man are either terrestrial—that is, belonging to the earth, and available without the influence of any external body—or meteoric—that is, belonging to bodies deposited on the earth from external space. The terrestrial sources, including mountain quarries and mines, the heat of hot springs, and the combustion of native sulphur, perhaps also the combustion of inorganic native combustibles, are actually used; but the mechanical effect obtained from them is very inconsiderable, compared with that which is obtained from sources belonging to the two classes mentioned above. Meteoric sources, including only the heat of newly-fallen meteoric bodies, and the combustion of meteoric iron, need not be reckoned among those available to man for practical purposes."

Thus we may summarize the natural sources of energy as Tides, Food, Fuel, Wind and Rain.

Among the practical sources of energy thus exhaustively enumerated, there is only one not derived from sun-heat—that is the tides. Consider it first. I have called it *practical*, because tide mills exist, but the places where they can work usefully are very rare, and the whole amount of work actually done by them is a drop to the ocean of work done by other motors. A tide of two meters' rise and fall, if we imagine it utilized to the utmost by means of ideal water wheels doing, with perfect economy, the whole work of filling and emptying a dock basin in infinitely short times, at the moments of high and low water, would give just one metre-ton per square metre of area. This work done four times in the twenty-four hours, amounts to 1.1620th of the work of a horse-power. Parenthetically, in explanation, I may say that the French metrical equivalent (to which in all scientific and practical measurements we are irresistibly drawn, notwithstanding a dense barrier of insular prejudice most detrimental to the islanders),—the French metrical equivalent of James Watt's "horse-power" of 550 foot-pounds per second, or 33,000 foot-pounds per minute, or nearly 2,000,000 foot-pounds per hour, is 75 metre-kilogrammes per second, or 4½ metre-tons per minute, or 270 metre-tons per hour. The French ton of 1000 kilos, used in this reckoning, is 0.984 of the British ton.

Returning to the question of utilizing tidal energy, we find a dock area of 162,000 square metres (which is little more than 400 metres square) required for 100-horse power. This, considering the vast costliness of dock construction, is obviously prohibitory of every scheme for economizing tidal energy by means of artificial dock basins, however near to the ideal perfection might be the realized tide-mill, and however convenient and non-wasteful the acumulator—whether Faure's electric accumulator, or other accumulators of energy hitherto invented, or to be invented,—which might be used to store up the energy yielded by the tide mill during its short harvests about the times of high and low water, and to give it out when wanted at other times of six hours. There may, however, be a dozen places possible in the world where it could be advantageous to build a sea-wall across the mouth of a natural basin or estuary, and to utilize the tidal energy of filling it and emptying it by means of sluices and water-wheels. But if *so* much could be done, it would in many cases take only a little more to keep the water out altogether, and make fertile land of the whole basin. Thus we are led up to the interest-

* British Association, 1881.

† Read at the Royal Society of Edinburgh on February 2, 1852. (*Proceedings* of that date.)

‡ A general conclusion equivalent to this was published by Sir John Herschel in 1833. See his "Astronomy," edit. 1849, § (399.)

ing economical question, whether is 40 acres (the British *agricultural* measure for the area of 162,000 square metres) or 100 horse-power more valuable? The annual cost of 100 horse-power night and day for 365 days of the year, obtained through steam from coals, may be about ten times the rental of forty acres, at £2 or £3 per acre. But the value of land is essentially much more than its rental, and the rental of land is apt to be much more than £2 or £3 per acre in places where 100 horse-power could be taken with advantage from coal through steam. Thus the question remains unsolved, with the possibility that in one place the answer may be *one hundred horse power*, and in another *forty acres*. But, indeed, the question is hardly worth answering, considering the rarity of the cases, if they exist at all, where embankments for the utilization of tidal energy are practicable.

Turning now to sources of energy derived from sun-heat, let us take the wind first. When we look at the register of British shipping, and see 40,000 vessels, of which about 10,000 are steamers and 30,000 sailing ships, and when we think how vast an absolute amount of horse-power is developed by the engines of those steamers, and how considerable a proportion it forms of the whole horse-power taken from coal annually in the whole world at the present time, and when we consider the sailing ships of other nations, which must be reckoned in the account, and throw in the little item of windmills, we find that, even in the present days of steam ascendancy, old-fashioned wind still supplies a large part of all the energy used by man. But however much we may regret the time when Hood's young lady, visiting the fens of Lincolnshire, at Christmas, and writing to her dearest friend in London (both sixty years old if they are now alive), describes the delight of sitting in a bower and looking over the wintry plain, not desolate, because "windmills lend revolving animation to the scene," we cannot shut our eyes to the fact of a lamentable decadence of wind-power. Is this decadence permanent, or may we hope that it is only temporary? The subterranean coal stores of the world are becoming exhausted surely, and not slowly, and the price of coal is upward bound—upward bound on the whole, though no doubt it will have ups and downs in the future as it has had in the past, and as must be the case in respect to every marketable commodity. When the coal is all burned, or long before it is all burned—when there is so little of it left, and the coal mines from which that little is to be excavated are so distant and deep and hot that its price to the consumer is greatly higher than at present, it is most probable that wind-mills or wind motors in some form, will again be in the ascendant, and that wind will do man's mechanical work on land at least, in proportion comparable to its present doing of work at sea.

Even now, it is not utterly chimerical to think of wind superseding coal in some places for a very important part of its present duty—that of giving light. Indeed, now that we have dynamos and Faure's accumulator, the little want to let the thing be done is cheap windmills. A Faure cell containing 20 kilos. of lead and minium charged and employed to excite incandescent vacuum-lamps has a light-giving capacity of 60 candle hours (I have found considerably more in experiments made by myself; but I take sixty as a safe estimate). The charging may be done uninjuriously, and with good dynamical economy in any time from six to twelve hours or more. The drawing off of the charge for use may be done safely, but somewhat wastefully, in two hours, and very economically in any time of from five hours to a week, or more. Calms do not last often longer than three or four days at a time. Suppose, then, that a five-days storage capacity, suffices (there may be a little steam engine ready to set to work at any time after a four days' calm, or the user of the light may have a few candles or oil lamps in reserve and be satisfied with them when the wind fails for more than five days.) One of the 20-kilo. cells charged when the windmill works, for five or six hours at any time and left with its 60 candle-hours' capacity to be used six hours a day for five days, gives a 2-candle light Thus thirty-two such accumulator cells soused would give as much light as four burners of London 16-candle gas. The probable cost of dynamo and accumulator does not seem fatal to the plan, if the windmill could be had for something comparable with the prime cost of a steam engine capable of working at the same horse power as the wind mill when in good action. But wind mills as hitherto made are very costly machines; and it does not seem probable that without inventions not yet made, wind can be economically used to give light in any considerable class of cases, or to put energy into store for other kinds of work.

Consider, lastly, rain-power. When it is to be had in places where power is wanted for mills and factories of any kind, water-power is thoroughly appreciated. From time immemorial, water-motors have been made in large variety for utilizing rain-power in the various conditions, in which it is presented, whether in rapdidly-flowing rivers in natural waterfalls, or stored at heights in natural lakes or artificial reservoirs. Improvements and fresh inventions of machines of this class still go on; and some of the finest principles of mathematical hydrodynamics have, in the lifetime of the British Association, and, to a considerable degree with its assistance, been put in requisition for perfecting the theory of hydraulic mechanism and extending its practical applications.

A first question occurs: Are we necessarily limited to such natural sources of water-power as are supplied by rain falling on hill-country, or may we look to the collection of rain-water in tanks placed artificially at sufficient heights over flat country to supply motive power economically by driving water-wheels? To answer it: Suppose a height of 100 metres, which is very large for any practicable building, or for columns erected to support tanks; and suppose the annual rainfall to be three-quarters of a metre (30 inches). The annual yield of energy would be 75 metre-tons per square metre of the tank. Now one horse-power for 365 times 24 hours is 236,500 foot-tons; and therefore, dividing this by 75, we find 3153 sq. metres as the area of our supposed tank required for a continuous supply of one horse-power. The prime cost of any such structure, not to speak of the value of the land which it would cover, is utterly prohibirory of any such plan for utilizing the motive power of rain. We may or may not look forward hopefully to the time when windmills will again "lend revolving animation" to a dull flat country; but we certainly need not be afraid that the scene will be marred by forests of iron columns taking the place of natural trees, and gigantic tanks overshadowing the fields and blackening the horizon.

To use rain-power economically on any considerable scale we must look to the natural drainage of hill country, and take the water where we find it either actually falling or stored up and ready to fall when a short artificial channel or pipe can be provided for it at moderate cost. The expense of acqueducts, or of underground water-pipes, to carry water to any great distance—any distance of more than a few miles or a few hundred yards—is much too great for economy when the yield to be provided for is *power*; and such works can only be undertaken when the *water itself* is what is wanted. Incidentally, in connection with the water supply of towns, some part of the energy due to the head at which it is supplied may be used for power. There are, however, but few cases (I know of none except Greenock) in which the energy to spare over and above that devoted to bringing the water to where it is wanted, and causing it to flow fast enough for convenience at every opened tap in every house or factory, is enough to make it worth while to make arrangements for letting the water-power be used without wasting the water-substance. The cases in which water-power

is taken from a town supply are generally very small, such as working the bellows of an organ, or "hair-brushing by machinery," and involve simply throwing away the used water. The cost of energy thus obtained must be something enormous in proportion to the actual quantity of the energy, and it is only the smallness of the quantity that allows the convenience of having it when wanted at any moment, to be so dearly bought.

For anything of great work by rain-power, the water-wheels must be in the place where the water supply with natural fall is found. Such places are generally far from great towns, and the time is not yet come when great towns grow by natural selection beside waterfalls for power; as they grow beside navigable rivers, for shipping. Thus hitherto the use of water-power has been confined chiefly to isolated factories which can be conveniently placed and economically worked in the neighborhood of natural waterfalls. But the splendid suggestion made about three years ago by Mr. Siemens in his presidential address to the institution of Mechanical Engineers, that the power of Niagara might be utilized, by transmitting it electrically to great distances, has given quite a fresh departure for design in respect to economy of rain-power. From the time of Joule's experimental electro-magnetic engines developing 90 per cent of the energy of a Voltaic battery in the form of weights raised, and the theory of the electro-magnetic transmission of energy completed thirty years ago on the foundation afforded by the train of experimental and theoretical investigations by which he established his dynamical equivalent of heat in mechanical, electric, electro-chemical, chemical, electro-magnetic, and thermoclastic phenomena, it had been known that potential energy from any available source can be transmitted electro-magnetically by means of an electric current through a wire, and directed to raise weights at a distance, with unlimitedly perfect economy. The first large-scale practical application of electro-magnetic machines was proposed by Holmes in 1854, to produce the electric light for lighthouses, and persevered in by him till he proved the availibility of his machine to the satisfaction of the Trinity House and the delight of Faraday in trials at Blackwall in April, 1857, and it was applied to light the South Foreland lighthouse on December 8, 1858. This gave the impulse to invention; by which the electro-magnetic machine has been brought from the physical laboratory into the province of engineering, and has sent back to the realm of pure science a beautiful discovery—that of the fundamental principle of the dynamo, made triply and independently, and as nearly as may be simultaneously, in 1867 by Dr. Werner Siemens, Mr. S. A. Varley, and Sir Charles Wheatstone; a discovery which constitutes an electro-magnetic analogue to the fundamental electrostatic principle of Nicholson's revolving doubler, resuscitated by Mr. C. F. Varley in his instrument "for generating electricity;" patented in 1860; and by Holtz in his celebrated electric machine; and by myself in my "replenisher" for multiplying and maintaining charges in Leyden jars for heterostatic electrometers, and in the electrifier for the siphon of my recorder for submarine cables.

The dynamos of Gramme and Siemens, invented and made in the course of these fourteen years since the discovery of the fundamental principle, give now a ready means of realizing economically on a large scale, for many important practical applications, the old thermo-dynamics of Joule in electro-magnetism; and, what particularly concerns us now in connection with my present subject, they make it possible to transmit electro-magnetically the work of waterfalls through long insulated conducting wires, and use it at distances of fifties or hundreds of miles from the source, with excellent economy—better economy, indeed, in respect to proportion of energy used to energy dissipated than almost anything known in ordinary mechanics and hydraulics for distances of hundreds of yards instead of hundreds of miles.

In answer to questions put to me in May, 1879,* by the Parliamentary Committee on Electric Lighting, I gave a formula for calculating the amount of energy transmitted, and the amount dissipated by being converted into heat on the way, through an insulated copper conductor of any length, with any given electro-motive force applied to produce the current. Taking Niagara as example, and with the idea of bringing its energy usefully to Montreal, Boston, New York, and Philadelphia, I calculated the formula for the distance of 300 British statute miles (which is greater than the distance of any of those four cities from Niagara, and is the radius of a circle covering a large and very important part of the United States and British North America), I found almost to my surprise that, even with so great a distance to be provided for, the conditions are thoroughly practicable with good economy, all aspects of the case carefully considered. The formula itself will be the subject of a technical communication to Section A in the course of the meeting on which we are now entering. I therefore at present restrict myself to a slight statement of results.

1. Apply dynamos driven by Niagara to produce a difference of potential of 80,000 volts between a good earth connection and the near end of a solid copper wire of half an inch (1.27 centimetre) diameter, and 300 statute miles (483 kilometres) length.

2. Let resistance by driven dynamos doing work, or by electric lights, or, as I can now say, by a Faure battery taking in a charge, be applied to keep the remote end at a potential differing by 64,000 volts from a good earth-plate there.

3. The result will be a current of 240 webers through the wire taking energy from the Niagara end at the rate of 26,250 horse-power, losing 5250 (or 20 per cent) of this by the generation and dissipation of heat through the conductor and 21,000 horse-power (or 80 per cent of the whole) on the recipients at the far end.

4. The elevation of temperature above the surrounding atmosphere, to allow the heat generated in it to escape by radiation and be carried away by convection is only about 20° Centigrade; the wire being hung freely exposed to air like an ordinary telegraph wire supported on posts.

5. The striking distance between flat metallic surfaces with difference of potentials of 80,000 volts (or 75,000 Daniell's) is (Thomson's "Electrostatics and Magnetism." § 340) only 18 millimetres, and therefore there is no difficulty about the insulation.

6. The cost of the copper wire, reckoned at 8d. per lb., is £37,000, the interest on which at 5 per cent is £1900 a year, If 5250 horse-power at the Niagara end costs more than £1900 a year, it would be better economy to put more copper into the conductor; if less, less. I say no more on this point at present, as the economy of copper for electric conduction will be the subject of a special communication to the Section.

I shall only say, in conclusion, that one great difficulty in the way of economizing the electrical transmitting power to great distances, or even to moderate distances of a few kiloms., is now overcome by Faure's splendid invention. High potential—as Siemens, I believe, first pointed out—is the essential for good dynamical economy in the electric transmission of power. But what are we to do with 80,000 volts when we have them at the civilized end of the wire? Imagine a domestic servant going to dust an electric lamp with 80,000 volts on one of its metals? Nothing above 200 volts ought on any account ever to be admitted into a house or ship or other place where safeguard against accident cannot be made absolutely and forever trustworthy against all possibility of accident. In an electric workshop 80,000 volts is no more dangerous than a circular saw. Till I learned Faure's invention I could but think of step-down dynamos, at a main receiving station to take energy direct from the electic main

* Printed in the Parliamentary Blue-book Report of the Committee on Electric Lighting, 1879.

with its 80,000 volts, and supply it by secondary 200-volt dynamos or 100-volt dynamos, through proper distributing wires, to the houses and factories and shops where it is to be used for electric lighting, and sewing machines, and lathes, and lifts, or whatever other mechanism wants driving power. Now the thing is to be done much more economically, I hope, and certainly with much greater simplicity and regularity, by keeping a Faure battery of 40,000 cells always being charged direct from the electric main, and applying a methodical system of removing sets of 50, and placing them on the town-supply circuits, while other sets of 50 are being regularly introduced into the great battery that is being charged, so as to keep its number always within 50 of the proper number, which would be about 40,000 if the potential at the emitting end of the main is 80,000 volts.

ON THE ARRESTATION OF INFUSORIAL LIFE.*

By PROF. TYNDALL.

Three years ago I brought with me to the Alps a number of flasks charged with animal and vegetable infusions. The flasks had been boiled from three to five minutes in London, and hermetically sealed during ebullition. Two years ago I had sent to me to Switzerland a batch of similar flasks containing other infusions. On my arrival here this year 120 of these flasks lay upon the shelves in my little library. Though eminently putrescible the animal and vegetable juices had remained as sweet and clear as when they were prepared in London. Still an expert taking up one of the flasks containing an infusion of beef or mutton would infallibly pronounce it to be charged with organisms. He would find it more or less turbid throughout, with massive flocculi moving heavily in the liquid. Exposure of the flask for a minute or two to lukewarm water would cause both turbitity and flocculi to disappear, and render the infusion as clear as the purest distilled water. The turbidity and flocculi are simply due to the coagulation of the liquid to a jelly. This fact is some guarantee for the strength of the infusions. I took advantage of the clear weather this year to investigate the action of solar light on the development of life in these infusions, being prompted thereto by the interesting observations brought before the Royal Society by Dr. Downs and Mr. Blunt, in 1877. The sealed ends of the flasks being broken off, they were infected in part by the water of an adjacent brook, and in part by an infusion well charged with organisms. Hung up in rows upon a board, half the flasks of each row were securely shaded from the sun, the other half being exposed to the light. In some cases, moreover, flasks were placed in a darkened room within the house, while their companions were exposed in the sunshine outside. The clear result of these experiments, of which a considerable number were made, is that by some constituent or constuents of the solar radiation an influence is exercised inimical to the development of the lowest infusoria. Twenty-four hours usually sufficed to cause the shaded flasks to pass from clearness to turbidity, while thrice this time left the exposed ones without sensible damage to their transparency. This result is not due to mere differences of temperature between the infusions. On many occasions the temperature of the exposed flasks was far more favorable to the development of life than that of the shaded ones. The energy which in the cases here referred to prevented putrefaction was energy in the radiant form. In no case have I found the flasks sterilized by insolation, for on removing the exposed ones from the open air to a warm kitchen they infallibly changed from cleaness to turbidity. Four and twenty hours were in most cases sufficient to produce this change. Life is, therefore, prevented from developing itself in the infusions as long as they are exposed to the solar light, and the paralysis thus produced enables them to pass through the night time without alteration. It is, however, a suspension, not a destruction, of the germinal power, for, as before stated, when placed in a warm room life was invariably developed. Had I had the requisite materials I should like to have determined by means of colored media, or otherwise, the particular constituents of the solar radiation which are concerned in this result. The rays, moreover, which thus interfere with life must be absorbed by the liquid or by its germinal matter. It would therefore be interesting to ascertain whether, after transmission through a layer of any infusion, the radiation still possessed the power of arresting the development of life in the same infusion. It would also be interesting to examine how far insolation may be employed in the preservation of meat from putrefaction. I would not be understood to say that it is impossible to sterilize an infusion by insolation, but merely to indicate that I have thus far noticed no case of the kind.

* British Association, 1881.

PLANTÉ'S RHEOSTATIC MACHINE.*

Translated from the French by the Marchioness CLARA LANZA.

Ruhmkorff's electric induction machine has proved in the most satisfactory manner that by the intermediary of inductive action, we can transform voltaic electricity into electricity of high tension. M. Bichat has likewise shown that by the same means, currents of high tension can be changed to currents of quantity, analogous to voltaic currents. M. Planté, with his secondary piles, has rendered this demonstration still more emphatic, and as his experiments demanded a greater tension than he was able to produce with his batteries, he undertook the manufacture of an apparatus by which he could obtain veritable discharges of static electricity, capable of forming at will, long thread-like sparks, or short, thick ones. In this way he was induced to make the battery of which we are about to speak, and which he calls the *rheostatic machine.*

Although this apparatus (fig. 1) was presented to the Academy of Sciences and exhibited to most of the physicians who witnessed M. Planté's fine experiments, it is as yet, but little known. Why this should be the case we are at a loss to understand, for it is one of the most perfect machines that can be employed in experiments of static electricity. Had the apparatus borne a foreign name, we are confident it would have attracted considerable attention long ago. It is much to be regretted that we are so constituted in France, that whatever is invented by an unknown man, a *savant* who does not rejoice in an established position or who is not a member of some scientific coterie originating from a celebrated school, is looked upon entirely as a matter of subordinate interest. "It is only an amateur's work," we hear on all sides for awhile and then the subject is dropped forever. In England it is quite different. Amateurs such as Grove, Gassiot, Warren, Delarue, Spottiswoode, Lords, Ross, Lindsay, Raleigh, Elphinstone and many others, find their efforts are appreciated as they deserve to be, and no one ever thinks of inquiring whether they are *savants* patented by the government or not.

M. Planté therefore, not being among the last-mentioned, was forced to meet with indifference which he forcibly overcame later by the fine work he performed with his accumulators. He was not so successful, unfortunately, with his rheostatic machine, and for this reason we shall dwell a little upon the important results it has afforded us.

M. Planté's machine consists of a series of condensers with mica plates, parallel one with the other and capable of being charged and discharged in a manner similar to his secondary batteries without any other alimentary electric source than these latter.

The various pieces composing the apparatus must be

* *La Lumière Electrique*, August 6th, 1881.

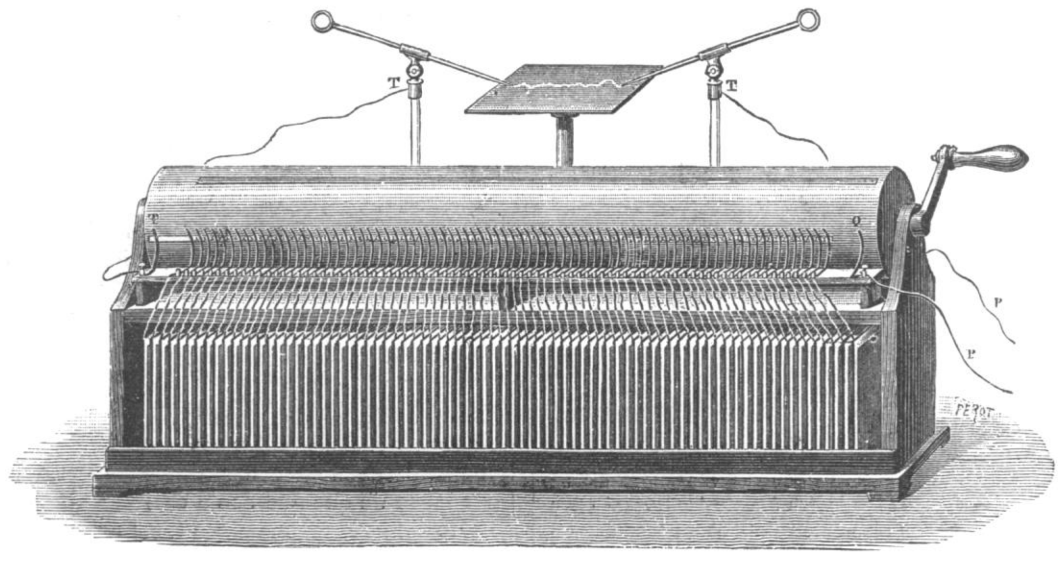

FIG. 1.

taken apart with great care. The commutator is formed of a long cylinder made of hard rubber. It is furnished with longitudinal metallic bands destined to connect the surface condensers, and crossed by pieces of copper wire bent at the ends, the object of the latter being to unite the condensers of tension. To this end, metallic wires, fashioned like springs, rest upon the cylinder and are associated with the two armatures of each condenser by very fine copper wires covered with gutta-percha. They are attached to an ebonite plaque on each side of the cylinder, and the latter can be made to rotate rapidly and continuously by means of a set of wheels. The final springs are separated considerably from those preceding them, in order to prevent the electric sparks from discharging between the tension poles of the rheostatic machine and those of the secondary battery.

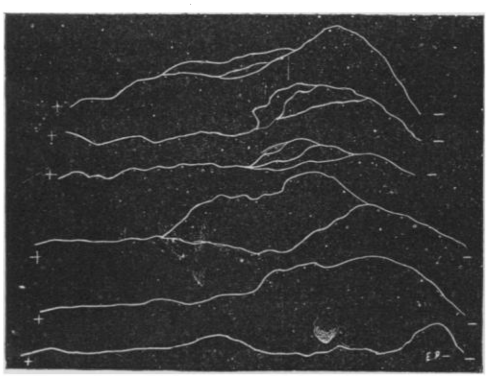

FIG. 2.

The mica plates in the condensers are 0^{m} 18 in length and 0^{m} 14 in breadth. The armatures are made of tinfoil. The edges of the condensers are rendered adherent by frames or simple ebonite plaques. These give them more rigidity and cause them more readily to maintain a vertical position, one beside the other, without coming in contact.

When the cylinder is so turned that the longitudinal metallic bands come in juxtaposition with the springs, the armatures in an even range with all the condensers unite on one side, while those in an uneven range are joined on the other, forming a single condenser of large surface. The armatures discharge by causing the right hand boundaries, which can be easily distinguished in the figure, to communicate with the poles of the battery.

When, on the contrary, the cylinder is so turned that its transversal pins are presented to the springs, all the charged condensers are connected in a series or in tension. The armature of the furthest condenser on the left, communicates with the last spring on the other side of the cylinder and ends at branch T of the excitant. The armature of the final condenser on the right communicates with the spring next to the last, and this spring unites with the last metallic pin traversing the cylinder. The last spring placed in the opposite side of the cylinder communicates with the other branch T′ of the excitant. While the condensers are thus connected, the pole, or battery, which charges the apparatus, is entirely beyond the circuit.

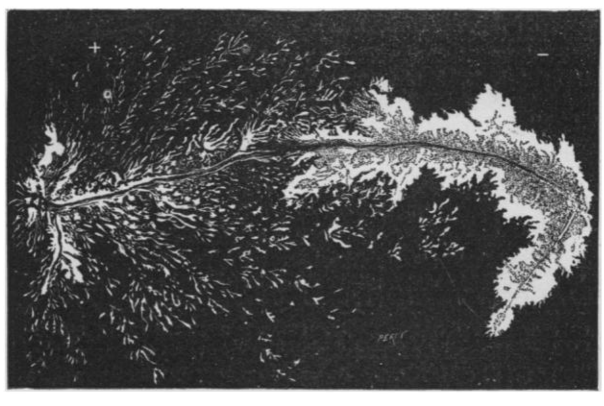

FIG. 3.

M. Planté has constructed rheostatic machines of different sizes. The one here represented is supplied with eighty condensers. The commutative cylinder is is one meter long and $0^{m}.15$ in diameter.

When this cylinder is put in motion and the machine connected with the battery of 800 secondary couples, we perceive, as the charge begins to act upon the commutator, long lines of sparks at those points where the metallic contact is effected. It becomes a tube of sparkling light and the effect is equally apparent when the discharge in tension occurs. At the same time we obtain a long spark at the excitant T T′.

Sparks produced by this machine attain, when fully exposed to the air, a length of 12 centimetres when influenced by the secondary battery of 800 couples. With less powerful machines, however, the length is reduced, and, according to M. Planté, it will be *in proportion to the number of condensers*. When a spark discharges across metallic filings it sometimes reaches the length of 70 centimetres.

We must remark here that discharges produced in this way have no alternate positive and negative sense, but are always the same. The loss of force resulting from the transformation should, therefore, be less than in induction machines; for as the Voltaic circuit is never closed upon itself for a single instant, no portion of the current is converted into a calorific effect. The machine, moreover, can be kept rotating for a long time and it produces a considerable number of discharges without any apparent weakness being visible on the part of the secondary battery.

The most interesting effects studied by M. Planté, by means of the sparks of this machine, were obtained by causing them to pass over pulverized sulphur in a compound of sulphur and minium. If these powders are spread upon a surface composed of resin and paraffine (1/10) the sparks, while passing over the sulphur, leave a bluish line distinctly visible, as though traced in black lead. This gives us an exact autograph, we may say, of the spark's course. It is easily effaced, however, by being rubbed. But if carefully followed and indented with some sharp pointed instrument it can be rendered intact. Afterwards we can study it thoroughly by tracing a drawing of it. The sparks represented by Fig. 2 were produced as above described.

When we come to investigate these sparks, we find, according to M. Planté, that when they have not the maximum of length which they are capable of attaining, they often display enclosed branches resembling *anastomoses*, and which are likely to escape while our attention is fixed upon the luminous track. Their sinuosities are always rounded, and that angular zig-zag, which is apparent in most electric sparks, is never seen. It is true that this form is sometimes indicated by effects of perspective when the flash is at the horizon. The sinuous shape, however, predominates, and frequently the spark resolves itself into two demi-undulations, forming a sort of S, which is also often seen in flashes of lightning that strike the ground. We find there particularly a very characteristic hook-shaped form, upon which M. Planté has long endeavored to attract attention, and which is produced at the negative pole in a constantly varying manner. M. Planté thinks the formation of this hook arises from the collision of two motions opposed to the ponderable matter drawn from the points of the excitant, an effect which always happens under an angle more or less pronounced, and with a more rapid movement on the side of the positive pole than the negative, doubtless because there is greater electric tension at the former. Our readers will probably recollect that I demonstrated this tension in several ways with the induced currents of Ruhmkorff's bobbin.[1]

If a portion of the sulphur spread upon the plate of the excitant is removed by giving the latter a few slight taps, the sparks change to luminous branch-like aigrettes which are truly magnificent. Fig. 3 represents one of these at its natural size, having a luminous track 15 centimetres in length. M. Planté calls these *arborescent sparks*, and he thinks they serve to explain those impressions of a vegetable appearance sometimes observed upon the bodies of persons struck by lightning, and which merely result from the ramifications of the fiery track made by the flash itself. He attributes these impressions to certain pulverulent particles which are in the course of the discharge, and which, after being projected into the air, heated or blazing, in various directions, fall upon the body that has been struck and produce a kind of cauterization if the particles are merely heated, and luminous impressions if they are blazing.

These experiments are extremely interesting, for they clearly show that the pretended reproduction of neighboring objects upon persons struck by lightning is purely imaginary.

If we neglect to give the taps, before mentioned, to the sulphur-powdered plate, the spark is displayed as represented by Fig. 4. We observe, in this case, that the size

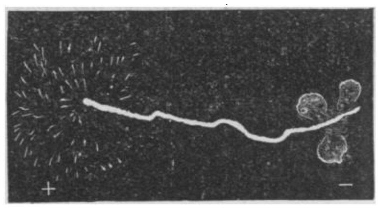

FIG. 4.

of the track is increased on the side of the positive pole, and grows contracted as it advances towards the negative pole. Around the positive pole we see traces corresponding to branches or rays in proportion to the quantity of sulphur removed. On the side of the negative pole we find circular tracks of an entirely different kind, representing, probably, the luminous spots, generally blue, which appear at the negative pole simultaneously with the spark of Ruhmkorff's bobbin.

If the plaque of the excitant belonging to M. Planté's apparatus is arranged so as to produce Lichtenberg figures—that is to say, covered with a compound of pure powdered resin, pulverized sulphur and minium—magnificent arborescent sparks of yet another kind can be obtained, the most curious examples of which are shown by Figs. 5 and 6. Tracings of these sparks are made by placing a sheet of varnished black paper upon the plate.

The different effects produced by the aigrettes and the sparks are particularly marked. When the distance between the points of the excitant is too great to admit of the spark discharging, and merely an aigrette appears, the electric movement of ponderable matter which leaves the negative pole and is manifested by the powdered minium adhering to the resin, does not extend to the positive pole. The latter presents no traces of red powder in the sulphur wreath and divergent rays surrounding it, as may be seen in Fig. 5. If the spark has

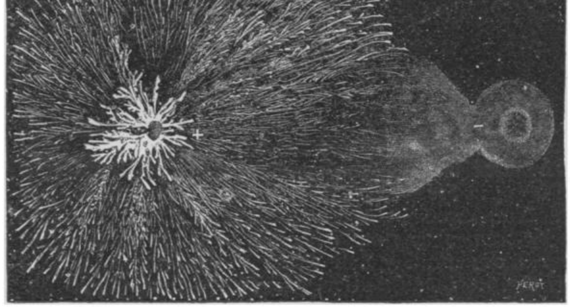

FIG. 5.

discharged, however, the wreath is open and the interior filled with red dust, showing that the electric movement proceeding from the negative pole, extends to the departing point of the positive electricity, as represented by Fig. 6.

[1] See Vol. II. of La Lumierè Electrique p. 439, and also a paper on *La non homogénéité de l'étincelle d'induction*, p. 89.

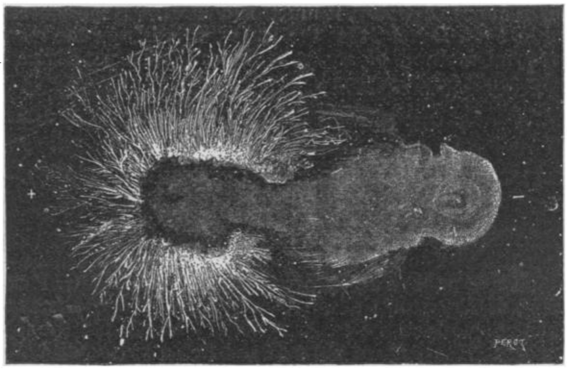

FIG. 6.

"With the spark," says M. Planté, "the distribution of negative electricity presents a curious crab-shaped appearance (Fig. 6.) With the aigrette, the electric movement around this same negative pole gives us the no less bizarre form of a polypus whose tentacles extend towards the positive pole, but do not reach it." (Fig. 5.)

From these results and other experiments quoted by M. Planté, he concludes that a blending of the two electricities may exist at each pole. This would infer that with electric currents of sufficient tension to obtain a continued series of discharges of static electricity, we could have a complete decomposition of the water at each pole and consequently a mixture of hydrogen and oxygen.

Pushing the study of these sparks still further, we find that the movement proceeding from the positive pole, externally, envelopes the negative electric movement like a bundle of curved sky-rockets. However, we often see at the same time an inward flux of positive electricity around the line of the spark between the positive current enveloping the exterior, and between both, the negative electric current which appears as though inhaled by the positive pole. This led M. Planté to suppose that the negative electricity, or else the ponderable matter which it carries with it, moves in an annular space furnished by the electrified matter proceeding from the positive pole. According to him, it would follow that the aspiratory or ascendant effects of the water obtained by electric currents of high tension might explain the ascension of water in a cloudy form as seen in water-spouts.

In a forthcoming article we will study other phenomena no less remarkable, which have been revealed by M. Planté's rheostatic machine. Among these are colored sparks and vibrations determined in a platinum wire traversed by a current of interrupted quantity, a phenomenon which can account for the effects produced in telephones by a simple wire crossed by a current.

TH. DU MARCEL.

To be continued.

ON A PROCESS FOR UTILIZING WASTE PRODUCTS AND ECONOMIZING FUEL IN THE EXTRACTION OF COPPER.*

BY J. DIXON (ADELAIDE, SOUTH AUSTRALIA.)

This paper contains an account of a process for extracting copper from sulphurous ores, in which the heat generated by the combination of the oxygen of the air with the sulphur of the ore is utilized for the smelting of the ore. This process is based upon experiments, which, although the author regards as incomplete, show (1) that the charge grows visibly hotter by simply blowing air through it; (2) that the melting of the raw ore or regulus and its reduction can be carried on in the same furnace; (3) that if the ore is in lumps, and fed at the top whilst the air is admitted by the side, a practically clean slagg can be obtained; but if added in a coarse powder, as it is generally found in the market, it either blows out again or chokes the furnace; (4) that a rough copper of about 96 per cent pure metal can be obtained by the successful working of this process.

*British Association, 1881.

ON THE CHEMICAL ACTION BETWEEN SOLIDS.*

BY PROF. THORPE, PH. D., F.R.S.

The author drew attention to the extremely rare instances of such action hitherto observed, showing how many of these might be explained on the supposition that combination actually occurred between the bodies either in solution or in a state of gas. For example, the formation of cement steel, by the combination of carbon with iron, which had long been adduced as an example of such combination between solids, was now explained by the fact that iron at a high temperature was permeable to gases, and that in the actual process of cementation oxides of carbon were formed, which were in reality conveyors of carbon to the metal. He then illustrated by experiments the formation of several compounds by bringing together the components in solid form, choosing as examples such as would manifest their formation by characteristic coloring. Thus, as instances, potassium iodide and mercuric chloride, potassium iodide and lead nitrate, and silver nitrate and potassium chromate, were powdered together in a mortar, and in each case evidence of an action was exhibited by the production of characteristic colors of the product of the reaction of these compounds. The author referred to the memoir of the Belgian phycisist, Prof. Spring, on the same subject, some of whose experiments he had repeated and in the main confirmed. One of the most remarkable results obtained by the Belgian professor was the formation of coal from peat by subjecting the latter material to a high pressure. Peat from Holland and Belgium, when exposed to a pressure of about 6,000 atmospheres, was, according to Spring, changed into a mass which in all physical characters resembled ordinary coal. Experiments of the same nature made by Dr. Thorpe with various samples of British peat yielded, however, a very dissimilar result. These experiments were made with pressures which were considerably less and more than those employed by Spring. Although solid, compact masses, hard and very much changed in structure, were attained, in no case was any product obtained which could be confounded with bituminous coal. He said it was highly improbable, on purely chemical grounds, that mere pressure had been little more than an important factor in the transformation of woody matter into coal.

A NEW DEMONSTRATION OF THE CARBONIC ACID OF THE BREATH.

BY C. F. CROSS.

Some time since I made the observation that the carbonic acid of the breath determines the liberation of iodine from a mixture of potassium iodide and iodate, and that the presence of starch renders the decomposition a very effective lecture-experiment, in demonstration of the presence of an active acid body in respired air. A friend to whom I lately communicated this result, threw doubt upon my interpretation, and while admitting the occurrence of the decomposition under the condition of respiring vigorously into the solution, preferred to attribute it to the action of the air or of acid vapors accidentally present. I therefore repeated the experiments

*British Association, 1881.

with special precautions, viz., washing the respired gases, and performing parallel experiments, in which, for the breath I substituted a rapid current of air, and lastly raising the latter to a temperature of 40° C. The result was to prove conclusively my original statement that the decomposition is brought about by a constituent of the respired air, and therefore by its carbonic acid. In performing this experiment it is only necessary to secure the neutrality of the solution ; this being done, the development of a full purple color occupies from two to three minutes.

It is evident that this demonstration of the presence of *some* acid body precedes the lime-water test in the logical development of the complete proof of the presence of *carbonic* acid.—*Chemical News.*

THE BEST METHOD OF MOUNTING WHOLE CHICK EMBRYO.*

By DR. CHARLES S. MINOT.

The blastoderm is removed and cleaned in the usual manner, and then floated out on a glass slide, where it remains permanently. It is carefully spread out and allowed to dry until the edges become glued to the slide. It is then treated with a 0.5 per cent osmic acid solution, until a slight browning occurs. Stain with picro-carmine. The next step is particularly important, because it prevents the further darkening by the osmium, which otherwise injures or ruins the specimen. Pour Müller's fluid, or 0.5 per cent chromic acid solution, on the slide, and leave it over night. The next morning the blastoderm is ready for dehydration by alcohol, and mounting in the usual manner in balsam or dammar lac. Embryos prepared in this manner make particulary beautiful specimens.

ON THE ALLEGED DECOMPOSITION OF THE ELEMENTS.†

BY PROF. DEWAR, M.A., F.R.S.

In his remarks Prof. Dewar dealt chiefly with the spectroscopic work from which Mr. Norman Lockyer had drawn conclusions very different from those of Professors Liveing and Dewar, especially concerning the value of evidence on the subject. Prof. Dewar argued that Mr. Lockyer's views regarding the existence of carbon vapor in the corona of the sun would not bear scientific investigation, and that his views regarding the modification of the spectrum of magnesium were equally illusory, and gave no proof of the decomposition of elementary substances. Finally he discussed Mr. Lockyer's theory of "basic lines," and addressed himself to a refutation of the same. The results recorded, he said, strongly confirmed Young's observations, and left little doubt that the few as yet unresolved coincidences either would yield to a higher dispersion, or were merely accidental. It would indeed be strange if amongst all the variety of chemical elements and the still greater variety of vibrations which some of them were capable of taking up, there were no two which could take up vibrations of the same period. They certainly should have supposed that substances like iron and titanium, with such a large number of lines, must each consist of more than one kind of molecule, and that not single lines, but several lines of each, would be found repeated with the spectra of some other chemical elements. The fact that hardly a single coincidence could be established was a strong argument that the materials of iron and titanium, even if they be not homogeneous, were still different from those of other chemical elements. The supposition that the different elements might be resolved into simple constituents and even into a single substance had long been a favorite speculation with chemists ; but however probable that hypothesis might appear *a priori*, it must be acknowledged, according to Prof. Dewar, that the facts derived from the most powerful method of analytical investigation yet devised, gave it but scant support.

* Read before the A. A. A. S., Cincinnati, 1881.

† British Association, 1881.

ASTRONOMY.

ELEMENTS AND EPHEMERIS OF COMET (*d*), 1881.—BARNARD.

Mr. S. C. Chandler, Jr., has computed the following elements and ephemeris of Comet (*d*), 1881—Barnard—which are published, by permission of Prof. E. C. Pickering, of Harvard College Observatory. The observations upon which the computation is based are the following : Washington Mean Time being given with the Nashville observation, which was obtained at Vanderbilt University, by Prof. O. H. Landreth, and Cambridge Mean Time with the two others :

		d.	*h.*	*m.*	*s.*		R. A. *h.*	R. A. *m.*	R. A. *s.*	Decl. °	Decl. ′	Decl. ″
1881.	Sept.	20	7	46		Nashville	13	28	2	+3	47	
		21	7	34	43	Harvard Obs.	13	30	20	4	54	
		25	7	17	52	Harvard Obs.	13	36	29.63	9	6	43.7

The observation of the 20th was received by telegraph, and that of the 21st depends on only two comparisons, taken when the comet was but one degree and a half above the horizon.

ELEMENTS.

T = 1881, September, 14.785. Washington Mean Time.

$$\left.\begin{array}{rcll} \pi &=& 271^\circ & 22' \\ \Omega &=& 260 & 43 \\ i &=& 107 & 27 \end{array}\right\} \text{Mean Eq., 1881. o.}$$

$$\log. q = 9.7053$$

EPHEMERIS.

Wash. midnight, 1881.	R. A. *h.*	R. A. *m.*	R. A. *s.*	Decl. °	Decl. ′	Log. *r*.	Log. Δ.	Light
Sept. 29	13	41	36	+13	4	9.7894	0.1350	1.00
Oct. 3	13	45	28	16	26	9.8270	0.1467	.80
7	13	48	40	19	29	9.8648	0.1569	.65
11	13	51	32	22	18	9.9014	0.1628	.52

The light of the comet on September 29 is taken as unity, and in this scale its light at discovery, on September 17, was 1.85. The orbit does not resemble that of any known comet.

The comet is circular, not over one minute of arc in diameter, with a very decided central condensation. Its collective brightness is not more than equivalent to that of an 8½ mag. star. The comet is rapidly decreasing in light, and the moon is advancing, so that observations of it at once are very desirable. So far as is known, positions have been obtained only at Nashville and Cambridge, the early setting of the comet, and clouds, having greatly interfered. Under the circumstances, the orbit cannot be other than a rough one, and considerable latitude for error had better be allowed in searching for it.

MICROSCOPY.

The following method of hardening the spinal cord for microscopic sections has been highly recommended by Dr. M. Debove :

Place the cord in a 4 per cent solution of bichromate of ammonia for three weeks, then in a solution of phenic gum for three days, and for three days more in alcohol. Sections may then be cut with great facility. They should be placed in water to prevent curling. They are then immersed in a saturated solution of picric acid for twenty-four hours, and colored with carmine for about twenty minutes, the picric acid acting as a mordant.—*Archives de Neurologie.*

An era of microtomes appears to be approaching, and numerous are such devices which are advertised by the opticians. Mr. Thomas Taylor of the Agricultural de-

partment, Washington, has arranged a new microtome in which all the parts are reduced to their most simple form. Mr. Taylor described his invention as consisting essentially of a thin brass tube about one inch and a half strength by one inch in diameter. A ¼ inch brass tube secured within the large cylinder. This tube enters the bottom where it is secured, and proceeds to within a quarter of an inch of the inside surface of the top. To the outside open end of this tube a rubber tube is attached; the other end of the rubber tube is made to communicate with a freezing mixture composed of finely cut ice and salt in about equal proportions. The pail containing this mixture is placed over and about fifteen inches higher than the section cutter. The object of this arrangement is to fill the brass cylinder with a freezing liquid drained from the pail, and caused by the liquefying salt and ice, the temperature of which is about zero. On filling the cylinder with the liquid any object on the top of the cylinder becomes frozen in a short period and may then be cut to any degree of thickness. In order to preserve the low degree of temperature in the cylinder a second tube is secured in the cylinder to remove air and keep up a constant current of the freezing liquid. This tube enters the bottom of the cylinder, where it is fastened. It projects upwards to within an eighth of an inch of the top and has a diameter of about one-half of the supply tube. This microtome or freezing cylinder in other respects is arranged like other microtomes, such as are used for ether or rhigoline; and the same mathematical accuracy attained in cutting sections,

THE editor of the *American Monthly Microscopical Journal* devotes an article to the selection of microscopes, and expresses his belief that the microscope of the future will be an instrument of quite moderate size, and about the same dimensions as that of the forms used by the German student. We believe this to be a correct view of the microscopist's requirements, if the instrument is employed as often as it should be. The colossal instruments which have been recently constructed show no advance in the manufacture of microscopes, but rather a return to the monstrosities of 100 years ago, when their size was "prodigious," and the display of ornamentation profuse. We once saw the microscope "built" for George III., which was a marvel of the brass finisher's art, as elaborate as a Louis XIV. clock, and probably as useful, as an optical instrument.

We believe the form of microscope which will be accepted as a standard by future microscopists will be the "Stevenson" model. Five years ago we submitted drawings for an inexpensive instrument on this plan, but was met by a variety of objections from opticians.

We now find that two London makers are offering microscopes on this model, the Stevenson form having been modified, so as to considerably reduce the expense. The advantages of this model is very great. *First*, a horizontal stage. *Second*, the comfort of sloping tubes. *Third*, an erected image.

We notice in the new edition of "Carpenter" (page 86) that such an instrument (binoculen) can be sold complete, with objective, for $100, or simplified as a student's microscope (binoculen, with 2 objectives) for $64.

For those who merely practice the refinements of the microscope, such an instrument would present many objections, but for biological studies and ordinary microscopical work, we strongly advocate its use, and desire to find it manufactured in its new and cheaper form by American manufacturers of microscopes.

PROF. ALEXIS A. JULIEN has published a reprint from the Journal of the Amer. Chemical Society of his paper "*On the Examination of Carbon Dioxide in the Fluid Cavities of Topaz.*" He describes two simple and inexpensive apparatus for the microscopical determination of carbonic acid in the cavities of minerals; and a recent study of large numbers of cleavage slices from fifty pebbles of topaz from Minas Geraes, Brazil, has presented facts of some interest hitherto not recorded. In some of the slices many extremely angular, elongated, branching, and even reticulated forms of considerable size and novelty abound. Their outlines are at many points decidedly crystalline, with arms projecting at an angle of about 135 degrees, which seems to indicate that Brewster's generalization, that the cavities were generally "capriciously distributed when the substance of the crystal was in a soft or plastic state," may have been pressed too far. In general, the larger expansions of the cavities are mostly occupied by brine, while their attenuated extremities and fine tubular connections are filled by liquid carbonic acid, occasionally including a bubble due to contraction.

MR. C. M. VORCE has forwarded to us a drawing of the many forms of microscopical life found by him in water from Lake Erie, and used as a water supply for Cleveland City. This appears to be but the first instalment of the subject. He draws and names nearly two hundred specimens.

PRELIMINARY REMARKS ON THE MICROSCOPIC STRUCTURE OF COAL FROM EAST SCOTLAND AND SOUTH WALES, by Prof. Williamson, F. R. S., Owens College.—This subject will not be worked out until ten years, but he described layers of vascular tissue which can be separated layer by layer, while in other cases the charcoal layer on the surface of the coal and the organic structure is not capable of separation, and he stated that charcoal contains a tubular structure, like tissues of ordinary bark. The association of tissues resembles that of Cycadian plants; and referred to the genus *Cordaites* having been proved to belong to this group by M. Renault; the author has made nearly a thousand distinct observations on the structure of coal. Separates ordinary coal with large quantities of mineral charcoal, with macrospores of Lepidendroid plants filled up with myriads of microspores which were certainly not floated to the spots, from the *paraffine coals* which do not contain these large macrospores. He divides coal into "Iso-sporous" coals and "Heterosporous" coals; both abound in *Cordaites*, which form the mineral charcoal.

NOTE ON THE OCCURRENCE OF SELENIUM AND TELLURIUM IN JAPAN, by E. DIVERS, M. D.—The author draws attention to the fact that the presence of these two elements has been observed in Japanese sulphuric acid, and considers it probable that these substances occur in material quantities in Japan.

BREWING IN JAPAN, by R. W. ATKINSON, B.SC. (LOND.)—The Japanese brewing process is divided into two parts comparable with the malting and brewing processes of beer-making. The mode of preparation and the properties of the diastatic materials are different in the two cases. The Japanese equivalent of malt or "köji" hydrates maltose in addition to cane-sugar, dextrin, and starch, and the ultimate products of its action on starch-paste are dextrose and dextrin, or perhaps dextrose alone. Köji differs from malt in being rendered inactive by heat at a much lower temperature than malt. Köji is prepared as follows: A mixture of steamed rice and water is allowed to remain in shallow tubs at a low temperature (0°–5° C.) until quite liquid; it is then heated, fermentation commences, and continues until nearly all the dextrine first formed is exhausted. This product is now used like yeast, and is added to fresh quantities of steamed rice and water, fermentation proceeding until the percentage of alcohol amounts to about 13 or 14 per cent by weight. After the greater part of the rice added has been used up, the mash is filtered and clarified by standing. The "saké" so produced requires very careful watching, and when summer approaches, or it exhibits signs of putrefactive fermentation, it is then heated in iron vessels; this operation has frequently to be repeated. Analyses of various specimens, fresh and diseased, are given in the paper.

BOOKS RECEIVED.

A TREATISE ON BRIGHT'S DISEASE AND DIABETES, WITH SPECIAL REFERENCE TO PATHOLOGY AND THERAPEUTICS. By JAMES TYSON, A. M., M. D., with Illustrations. Including a section on Retinitis in Bright's Disease. By WIILLIAM F. NORRIS., A. M, M. D. Lindsay and Blackiston, Philadelphia. 1881.

Dr. Tyson needs no apology for publishing this work, and we express the hope that it will be extensively read by the medical profession.

It is true that many excellent treatises exist on this subject, but a mere glance at Dr. Tyson's work shows that in it the subject has been treated in a manner that is original, presenting all the facts in a concise form, and yet omitting no detail which is essential for the full comprehension of this intricate and difficult subject.

Those who have watched the course of recent literature relating to Diseases of the Kidneys and Glycosuria, are aware that we are very far from possessing precise knowledge in regard to such complications, and that while we are still ignorant of the precise pathology of some of these diseases, the very facts bearing on the subject are in a chaotic condition, and inaccessible to the majority of those who should be well informed.

The writer of this book is an accomplished writer, and one who has during the past fifteen years devoted his thoughts and studies to these subjects, and also engaged in practical work bearing on them. Surely the result of such an experience must be useful to both experts and students, if properly used and appreciated.

The number of calls made upon physicians by patients suffering from various forms of Bright's disease and Diabetes is daily on the increase, and no one knows better than the intelligent practitioner, that a large number of their confrères are miserably ignorant on the subject, unacquainted with the Pathology of these diseases, and disgracefully incompetent to treat them. We are not now speaking of quacks, but holders of medical diplomas.

Cases have come to our knowledge, where patients have succumbed on account of their physicians being unable to make a proper diagnosis of the diseases we refer to, or even to analyze or report on a sample of urine.

To such Dr. Tyson's work will probably still be a sealed book, but the advanced and intelligent physicians will, under our advice, procure a copy, for, although other works on this subject may have been studied with profit, we believe a perusal of the work before us will still contribute to his knowledge of this important and interesting subject.

SOLAR PHYSICS.—In concluding a series of lectures on Solar Physics, Professor J. Norman Lockyer said: "I am in honor bound to say, as the result of the work on our solar physics, in that small branch of the inquiry into solar matters with which I am more personally connected, that my belief is that the late work has changed the views which were held, say twenty years ago, to this extent: whereas twenty years ago, we imagined ourselves to be in full presence in the sun of chemical forms with which we are familiar here, I think in this present year, we are bound to consider that that view may be modified to a certain extent, and that we are justified in holding the view, that not these chemical forms with which we are acquainted here, but their germs really, are revealed to us in the hottest regions of the sun."

METEOROLOGICAL REPORT FOR NEW YORK CITY FOR THE WEEK ENDING OCT. 1, 1881.

Latitude 40° 45′ 58″ N.; Longitude 73° 57′ 58″ W.; height of instruments above the ground, 53 feet; above the sea, 97 feet; by self-recording instruments.

SEPTEMBER AND OCTOBER.	BAROMETER. Mean for the day. Reduced to Freezing.	BAROMETER. Maximum. Reduced to Freezing.	Maximum. Time.	BAROMETER. Minimum. Reduced to Freezing.	Minimum. Time.	THERMOMETERS. Mean. Dry Bulb.	Mean. Wet Bulb.	Maximum. Dry Bulb.	Time.	Maximum. Wet Bulb.	Time.	Minimum. Dry Bulb.	Time.	Minimum. Wet Bulb.	Time.	Maxi'm In Sun.
Sunday, 25	29.936	30.000	7 a. m.	29.892	5 p. m.	79.3	70.3	89	4 p. m.	73	4 p. m.	71	6 a. m.	67	7 a. m.	143.
Monday, 26	29.943	29.986	9 a. m.	29,900	5 p. m.	81.6	72.0	91	3 p. m.	75	3 p. m.	73	7 a. m.	69	7 a. m.	145.
Tuesday, 27	29.937	29.994	9 a. m.	29.900	9 p. m.	79.7	72.7	86	3 p. m,	76	3 p. m.	75	5 a. m.	70	5 a. m.	139.
Wednesday, 28	29.933	30.018	12 p. m.	29.890	3 p. m.	78.0	70.0	88	4 p. m.	73	5 p. m.	71	12 p. m.	68	12 p. m.	143.
Thursday, 29	30.196	30.238	9 p. m.	30.018	0 a. m.	69.6	64.3	75	3 p. m.	66	3 p. m.	64	12 p. m.	62	12 p. m.	134.
Friday, 30	30.189	30.238	9 a. m.	30.108	5 p. m.	74.0	68.6	82	3 p. m.	74	3 p. m.	64	0 a. m.	62	0 a. m.	138.
Saturday, 1	30.156	30.198	12 p. m.	30.100	3 p. m.	79.0	69.6	87	3 p. m.	72	6 p. m.	72	4 a. m.	67	0 a. m.	141.

Mean for the week .... 30.042 inches.
Maximum for the week at 9 a. m., Sept. 30th .... 30.238 "
Minimum " at 3 p. m., Sept. 28th .... 29.890 "
Range .... .348 "

	Dry.		Wet.	
Mean for the week	77.3	degrees	69.6	degrees.
Maximum for the week, at 3 pm. 26th	91.	" at 3 pm 27th,	76.	"
Minimum " " 12 pm. 29th	64.	" at 12 pm 29th,	62.	"
Range " "	27.	"	14.	"

SEPTEMBER AND OCTOBER.	WIND. Direction. 7 a. m.	Direction. 2 p. m.	Direction. 9 p. m.	Velocity in miles. Distance for the Day.	Force in lbs. per sqr. feet. Max.	Force. Time.	HYGROMETER. Force of vapor. 7 a. m.	Force of vapor. 2 p. m.	Force of vapor. 9 p. m.	Relative humidity. 7 a. m.	Relative humidity. 2 p. m.	Relative humidity. 9 p. m.	CLOUDS. Clear, 0; Overcast, 10. 7 a. m	2 p. m.	9 p. m.	RAIN AND SNOW. Depth of rain and snow in inches. Time of Beginning.	Time of Ending.	Duration. h. m.	Amount of water	OZONE. 0 10
Sunday, 25	w. s. w.	s. w.	s. w.	233	5½	3.00 pm	.595	.596	.677	76	48	66	0	2 cir. cu.	0	-----	-----	-----	--	0
Monday, 26	w.	s. s. w.	s. w.	177	1¾	3.00 pm	.655	.665	.650	80	47	59	0	2 cu.	0	-----	-----	-----	--	0
Tuesday, 27	s. s. w	s.	s. w.	145	3¼	2.30 pm	.652	.733	.744	72	61	77	2 cir.	3 cir. cu.	2 cu. s.	4.30pm	5.30pm	1.00	.04	0
Wednesday, 28	w. s. w.	w.	n.	221	7¼	5.40 pm	.666	.596	.618	77	48	76	4 cir. cu.	4 cu.	2 cu.	-----	-----	-----	--	0
Thursday, 29	e. n. e.	e.	e. s. e.	174	3½	10.20 am	.516	.545	.536	70	67	84	2 cir. cu.	7 cir. cu.	10	-----	-----	-----	--	0
Friday, 30	n. e.	s.	s. w.	146	6¾	7.00 pm	.569	.703	.628	89	66	72	10	2 cu.	0	-----	-----	-----	--	0
Saturday, 1	w. s. w.	w. s. w.	s. w.	199	3	7.20 am	.631	.518	.651	80	41	66	5 cir. cu.	2 cir. cu.	0	-----	-----	-----	--	0

Distance traveled during the week .... 1,295 miles.
Maximum force .... 7¼ lbs.

Total amount of water for the week .... .04 inch
Duration of rain .... 1 hours, 00 minutes

DANIEL DRAPER, Ph. D.

Director Meteorological Observatory of the Department of Public Parks, New York.